

Illustrating Student Achievement

Using National Assessment of Educational Progress Questions:

Grade 8

Functions Domain

The Montana Office of Public Instruction (OPI) adopted new standards for language arts and mathematics in November 2011. The new standards will be implemented in the 2013-2014 school year with the Smarter Balanced (SBAC) assessment taking place in the spring of 2014.

This document uses National Assessment of Education Progress (NAEP) questions that seem to have a close alignment with the new standards to illustrate or suggest current levels of student achievement for the new standards. It is not intended to make any predictions about how students will do on a new assessment but may have instructional implications in terms of showing students' strengths and weaknesses. NAEP releases some items after each NAEP administration; performance data is given for the nation and states for each released item. Since 2003, every state has participated in the grade 4 and grade 8 NAEP mathematics and language arts assessments, which are given every other year. SBAC released practice tests matching the Functions domain have been included in this document as another example to illustrate the standards. There are no NAEP 2013 released questions as examples but these questions may be accessed via the [NAEP Questions Tool \(NQT\)](#).

This work has been made available through the **National NAEP Year Projects (NNYP)**. This document parallels the work of Alaska's NAEP state coordinator. The following jurisdictions have made this information possible: Alaska, Iowa, New York, Florida, Oregon and the District of Columbia. For more information and resources, please visit:

- [Alaska Department of Education](#)
- [Iowa Department of Education](#)
- [NYC Department of Education](#)
- [Florida Department of Education](#)
- [Oregon Department of Education](#)
- [District of Columbia](#)
- [AIR: Examining the Content and Context of the Common Core State Standards: A First Look at Implications for the National Assessment of Educational Progress](#)



Montana
Office of Public Instruction
Denise Juneau, State Superintendent

A note about NAEP performance: NAEP rates multiple-choice or constructed-response questions scored either right or wrong as “easy” if answered correctly by 60% or more of students, “medium” is answered correctly by 40 to 59%, or “hard” if answered correctly by fewer than 40%.

Montana Common Core Standards (MCCS):

Define, evaluate, and compare functions.

- **8.F.1.** Understand that a function is a rule that assigns to each input (the domain) exactly one output (the range). The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. For example, use the vertical line test to determine functions and non-functions.
- **8.F.2.** Compare properties of two functions, each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.*
- **8.F.3.** Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. *For example, the function $A = s^2$ giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.*

Use functions to model relationships between quantities.

- **8.F.4.** Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.
- **8.F.5.** Given a verbal description between two quantities, sketch a graph. Conversely, given a graph, describe a possible real-world example. For example, graph the position of an accelerating car or tossing a ball in the air.

Represent and analyze quantitative relationships between dependent and independent variables.

- **6.EE.9.** Use variables to represent two quantities in a real-world problem from a variety of cultural contexts, including those of Montana American Indians, that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation $d = 65t$ to represent the relationship between distance and time.

Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

- **7.EE.3.** Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations as strategies to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. For example: If a woman making \$25 an hour gets a 10% raise, she will make an additional $\frac{1}{10}$ of her salary an hour, or \$2.50, for a new salary of \$27.50. If you want to place a towel bar $9\frac{3}{4}$ inches long in the center of a door that is $27\frac{1}{2}$ inches wide, you will need to place the bar about 9 inches from each edge; this estimate can be used as a check on the exact computation.

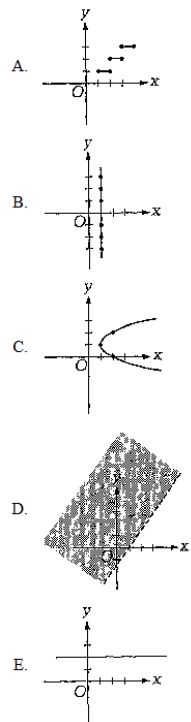
For more information on the MCCS- Grade Level Standards by Domain and Cluster, please visit:

http://opi.mt.gov/Curriculum/montCAS/MCCS/index.php?gpm=1_4

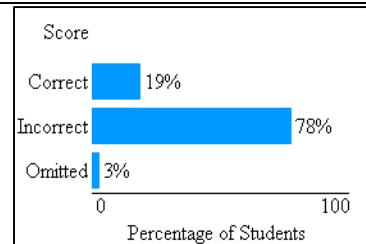
Year	Grade	Block	#	Type	Difficulty	Content Area	% Correct	Item	Description	Iowa CCSS Code	Alaska CCSS Code
1996	12	10	9	MC	Hard	Algebra and functions	20.19	Item1	Identify Graph of Function	8.F.1	8.F.1
2003	8	6	27	MC	Medium	Algebra and functions	44.83	Item2	Relate equation to ordered pairs	8.F.4	8.F.1
2005	8	4	20	ECR	Medium	Algebra	44.16	Item3	Use graph of two linear equations to solve a problem	8.F.4	8.F.4
2005	8	12	17	MC	Medium	Algebra	53.56	Item4	Determine an equation given a table of x and y values	8.F.2	8.F.1.
2005	12	12	17	MC	Hard	Algebra	26.43	Item5	Determine the increase in ticket prices from a cost model (calculator available)	7.EE.3	8.F.4.
2007	8	7	15	MC	Medium	Algebra	53.64	Item6	Determine equation relating sales and profit (calculator available)	6.EE.9	8.F.1.
2011	8	8	15	ECR	Easy	Algebra	60.66	Item7	Solve problems based on a linear graph (calculator available)	8.F.5	8.F.5
2011	8	12	9	MC	Easy	Algebra	70.35	Item8	Find interval of largest change on graph	8.F.5	8.F.3.
2011	8	12	10	SCR	Easy	Algebra	72.31	Item9	Read information from the graph of a function	8.F.5	8.F.3.
2011	8	12	15	MC	Medium	Algebra	48.25	Item10	Interpret a linear equation in context	8.F.4	8.F.4
#	#	#	#	#	#	#	#	Item11	SBAC Practice Item (23)	#	

NAEP Content Area: Algebra Question: Determine an equation given a table of x and y values. Gr.8. 2005. Item4 Iowa CCSS classification: 8.F.2; Alaska CCSS classification: 8.F.1.	National Data:	MT Data:																				
<table><tr><td>x</td><td>y</td></tr><tr><td>0</td><td>-1</td></tr><tr><td>1</td><td>2</td></tr><tr><td>2</td><td>5</td></tr><tr><td>3</td><td>8</td></tr><tr><td>10</td><td>29</td></tr></table> <p>Which of the following equations represents the relationship between x and y shown in the table above?</p> <p>A. $y = x + 1$ B. $y = x + 1$ C. $y = 3x - 1$ D. $y = x - 3$ E. $y = 3x - 1$</p>	x	y	0	-1	1	2	2	5	3	8	10	29	<table><tr><td>Score</td><td></td></tr><tr><td>Correct</td><td>54%</td></tr><tr><td>Incorrect</td><td>45%</td></tr><tr><td>Omitted</td><td>1%</td></tr></table> <p>0 100 Percentage of Students</p>	Score		Correct	54%	Incorrect	45%	Omitted	1%	<p>53% correct</p> <p>Answer: C</p>
x	y																					
0	-1																					
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Score																						
Correct	54%																					
Incorrect	45%																					
Omitted	1%																					
NAEP Content Area: Algebra and functions Question: Relate equation to ordered pairs. Gr.8. 2003. Item2 Iowa CCSS classification: 8.F.4; Alaska CCSS classification: 8.F.1.	National Data:	MT Data:																				
<table><tr><td>x</td><td>y</td></tr><tr><td>0</td><td>-3</td></tr><tr><td>1</td><td>-1</td></tr><tr><td>2</td><td>1</td></tr></table> <p>Which of the following equations is true for the three pairs of x and y values in the table above?</p> <p>A. $3x + 2 = y$ B. $3x - 2 = y$ C. $2x + 3 = y$ D. $2x - 3 = y$ E. $x - 3 = y$</p>	x	y	0	-3	1	-1	2	1	<table><tr><td>Score</td><td></td></tr><tr><td>Correct</td><td>45%</td></tr><tr><td>Incorrect</td><td>52%</td></tr><tr><td>Omitted</td><td>3%</td></tr></table> <p>0 100 Percentage of Students</p>	Score		Correct	45%	Incorrect	52%	Omitted	3%	<p>46% correct</p> <p>Answer: D</p>				
x	y																					
0	-3																					
1	-1																					
2	1																					
Score																						
Correct	45%																					
Incorrect	52%																					
Omitted	3%																					
NAEP Content Area: Algebra and functions Question: Identify Graph of Function. Gr.12. 1996. Item1 Iowa CCSS classification: 8.F.1; Alaska CCSS classification: 8.F.1.	National Data:	MT Data:																				

Which of the following could be the graph of a function?



Note: This is a grade 12 NAEP item but it is given as an example because it aligns to the new mathematics standard. Performance data is for 12th graders.



Answer:
E

No data for states for grade 12

NAEP Content Area: Algebra

Question: Determine equation relating sales and profit (calculator available). Gr.8. 2007. Item6

Iowa CCSS classification: 6.EE.9; **Alaska CCSS classification:** 8.F.1.

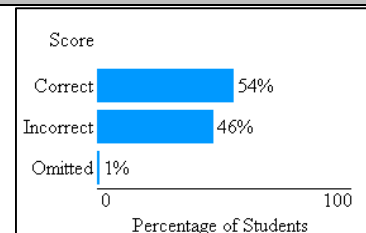
National Data:

MT Data:

	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
Number Sold, n	4	0	5	2	3	6
Profit, p	\$2.00	\$0.00	\$2.50	\$1.00	\$1.50	\$3.00

Angela makes and sells special-occasion greeting cards. The table above shows the relationship between the number of cards sold and her profit. Based on the data in the table, which of the following equations shows how the number of cards sold and profit (in dollars) are related?

- A. $p = 2n$
- B. $p = 0.5n$
- C. $p = n - 2$
- D. $p = 6 - n$
- E. $p = n + 1$



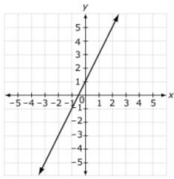
53% correct

Answer: B

SBAC Practice Test Item, Item11

Alaska CCSS classification: 8.F.2.

Look at this graph of a function.



Which equation represents a function with a rate of change that is **greater than** the rate of change of the function shown in the graph?

- (A) $y = 3x - 1$
- (B) $y = \frac{x}{2} + 4$
- (C) $y = 2x + 2$
- (D) $y = \frac{x}{3} - 3$

For this item, a full-credit response (1 point) includes:

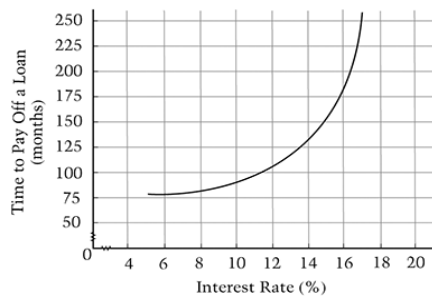
- option A

NAEP Content Area: Algebra

Question: Find interval of largest change on graph. Gr.8. 2011. Item8

Iowa CCSS classification: 8.F.5; **Alaska CCSS classification:** 8.F.3.

TIME TO PAY OFF A LOAN

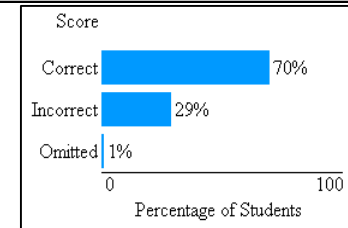


According to the graph, between which of the following pairs of interest rates will the increase in the number of months to pay off a loan be greatest?

- A. 7% and 9%
- B. 9% and 11%
- C. 11% and 13%
- D. 13% and 15%
- E. 15% and 17%

National Data:

MT Data:



76% correct

Answer: E

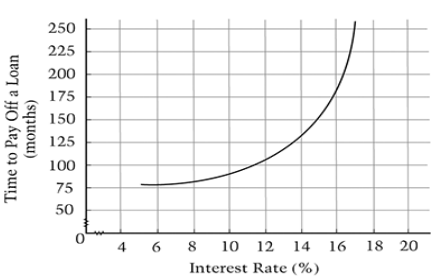
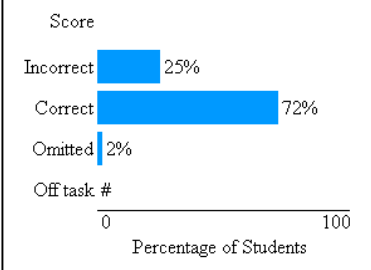
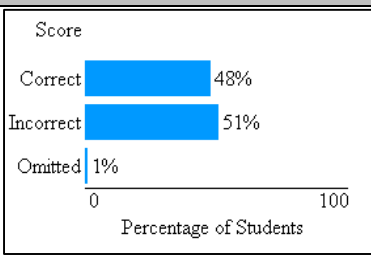
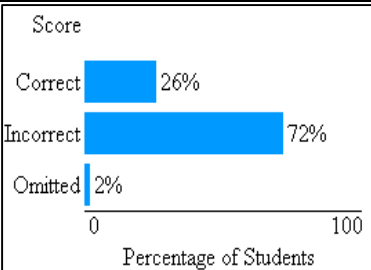
NAEP Content Area: Algebra

Question: Read information from the graph of a function. Gr.8. 2011. Item9

Iowa CCSS classification: 8.F.5; **Alaska CCSS classification:** 8.F.3.

National Data:

MT Data:

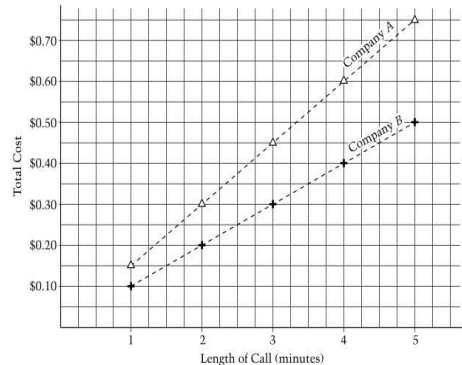
<p>TIME TO PAY OFF A LOAN</p>  <p>Mrs. Brown would like to pay off a loan in 180 months. According to the graph, what should be the approximate percent of the interest rate on her loan?</p> <p>Answer: _____</p>		<p>80% correct</p> <p>Answer: about 16%</p>
<p>NAEP Content Area: Algebra</p> <p>Question: Interpret a linear equation in context. Gr.8. 2011. Item10</p> <p>Iowa CCSS classification: 8.F.4; Alaska CCSS classification: 8.F.4.</p> <p>The number of gallons of water, y, in a tank after x hours may be modeled by the linear equation $y = 800 - 50x$. Which of the following statements about the tank is true?</p> <ol style="list-style-type: none"> It is filling at a rate of 800 gallons per hour. It is filling at a rate of 50 gallons per hour. It is emptying at a rate of 16 gallons per hour. It is emptying at a rate of 50 gallons per hour. It is emptying at a rate of 800 gallons per hour. 	<p>National Data:</p> 	<p>MT Data:</p> <p>52% correct</p> <p>Answer: D</p>
<p>NAEP Content Area: Algebra</p> <p>Question: Determine the increase in ticket prices from a cost model (calculator available). Gr.12. 2005. Item5</p> <p>Iowa CCSS classification: 7.EE.3; Alaska CCSS classification: 8.F.4.</p> <p>Yvonne has studied the cost of tickets over time for her favorite sports team. She has created a model to predict the cost of a ticket in the future. Let C represent the cost of a ticket in dollars and y represent the number of years in the future. Her model is as follows.</p> $C = 2.50y + 13$ <p>Based on this model, how much will the cost of a ticket <u>increase</u> in two years?</p> <ol style="list-style-type: none"> \$5 \$8 \$13 \$18 \$26 <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p>Note: This is a grade 12 NAEP item but it is given as an example because it aligns to the new mathematics standard. Performance data is for 12th graders.</p> </div>	<p>National Data:</p> 	<p>MT Data:</p> <p>Answer: A</p> <p>No data for states for grade 12</p>

NAEP Content Area: Algebra

Question: Use graph of two linear equations to solve a problem. Gr.8. 2005. Item3

Iowa CCSS classification: 8.F.4; **Alaska CCSS classification:** 8.F.4.

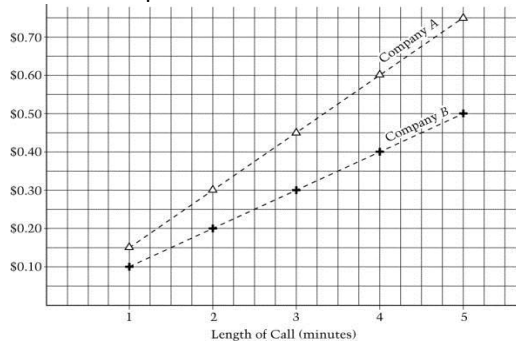
The graph below shows the cost that two long-distance telephone companies each charge for calls of various lengths (in minutes).



a. What is the cost of a 4-minute call using Company B ?

b. What is the cost per minute for a call using Company B ?

c. Determine the amounts of money saved (in cents) by using Company B instead of Company A when calls of 1, 2, 3, 4, and 5 minutes are made. Then graph the five points that represent the savings on the grid below and connect the points with a dotted line.



NAEP Content Area: Algebra

Question: Solve problems based on a linear graph. Gr.8. 2011. Item7
Iowa CCSS classification: 8.F.5; **Alaska CCSS classification:** 8.F.5

Key/Scoring Guide:

Sample Correct Response

The response is made of five attributes: one for part a, one for part b, and three for part c. For part c, the first attribute is for drawing any line that starts at (1, 0.05), the second attribute is awarded if the drawn line is correct but solid instead of dotted, and the third attribute is awarded for drawing a correct dotted line.

- a. 40 cents
- b. 10 cents per minute
- c. Points should fall on the line through (1, 0.05) and (5, 0.25).

(Note: line contains the points (1, 0.05), (2, 0.10), (3, 0.15), (4, 0.20), and (5, 0.25))

NOTE: An alternate partially correct approach to part c would involve listing the amounts saved (5, 10, 15, 20, and 25 cents), but not graphing the points. This would earn one attribute for part c.

Score & Description

Extended

Correct response (all five attributes)

Satisfactory

Three or four attributes

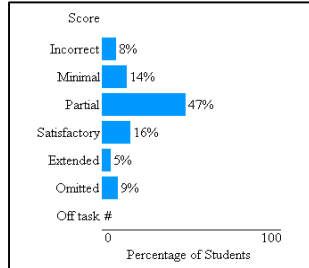
Partial

Two attributes

Minimal

One attribute

National Data:



MT Data:

7% extended

16% satisfactory

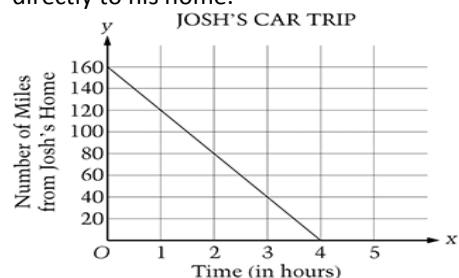
51% partial

Key/Scoring Guide:

National Data:

MT Data:

The linear graph below describes Josh's car trip from his grandmother's home directly to his home.



- Based on this graph, what is the distance from Josh's grandmother's home to his home?
- Based on this graph, how long did it take Josh to make the trip?
- What was Josh's average speed for the trip? Explain how you found your answer.
- Explain why the graph ends at the x-axis.

Sample Correct Response:

- 160 miles
- 4 hours
- 40 miles per hour

Explanation:

$$\frac{160 \text{ miles}}{4 \text{ hours}} = 40 \text{ miles per hour}$$

OR

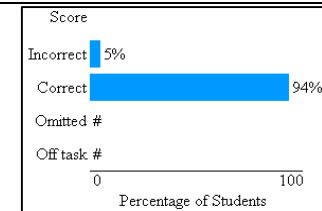
The slope of the line is -40, so the average speed is 40 miles per hour.

(Also accept a correctly computed response based on incorrect answers to parts (a) and (b).)

- You cannot have a negative distance, which is what you would have if you extended the line below the x-axis.

OR

Because that is 0 miles from his home, which means he has no farther to go.



Part a)
93% correct

Part b)
94% correct

Part c)
60% correct1

Part c)
#% correct2

Part d)
23% correct